Original Article

COVID-19 and Patients With Cancer: Investigating Treatment Impact, Information Sources, and COVID-19–Related Knowledge, Attitudes, and Practices

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BACKGROUND: The coronavirus disease 2019 (COVID-19) pandemic has caused enormous strain on public health. Patients with cancer are particularly susceptible to the disease, and their treatment plans have been threatened by public health restrictions designed to contain the spread. **METHODS:** This study examined the effects of the pandemic on cancer patients' psychology, knowledge, attitudes, and practices concerning COVID-19 as well as their perceptions of the impact of COVID-19 on their cancer health care services. A survey was sent to 5800 patients at a cancer center in Toronto, Canada. Descriptive results were summarized. Qualitative feedback was coded and summarized. To examine for potential associations, regression models were tested for the outcomes of patient psychological well-being, knowledge, attitudes, and practices, and they accounted for several demographic, health literacy, and disease variables. **RESULTS:** A total of 1631 surveys were completed. Most patients saw their appointments shifted to virtual visits, and for a substantial minority, there was no change. A majority of the patients (62%) expressed fears about contracting the virus. There were no independent predictors of COVID-19–related knowledge. Fears were more pronounced among patients who did not speak English and those who used social media more often. Female participants, those who scored higher on knowledge questions, and those who used cancer center materials were more likely to take preventative measures against infection. **CONCLUSIONS:** This study provides a snapshot of the state of cancer patient treatment and the knowledge, attitudes, and practices of patients between the first 2 waves of the pandemic. The study's results can inform our understanding of adaptation to conditions during and after the outbreak. *Cancer* 2022;128:746-761. © 2021 American Cancer Society.

KEYWORDS: cancer, coronavirus disease 2019 (COVID-19), health literacy.

INTRODUCTION

The emergence of the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) during 2019 resulted in the global coronavirus disease 2019 (COVID-19) pandemic, which has claimed more than 4.5 million lives in 2 years.[1] The disease has proven to be highly contagious, and it has created significant burdens for health care systems that have necessitated the implementation of emergency measures worldwide to limit its spread. COVID-19 is of particular concern for patients with cancer, who are at increased risk of experiencing complications if they contract the virus and are at increased risk of succumbing to the disease.[2,3] Mortality among patients with cancer hospitalized for COVID-19 is approximately 8% to 9% greater in comparison with the general population, although it remains unclear which factors (patient characteristics, treatment, or cancer type) are driving this phenomenon.[4] To prevent the spread of the disease, reduce pressures on health system capacity, and safeguard vulnerable patients, hospitals have curtailed in-person visits in favor of virtual care.

Theories on crisis management state that effective communication and appropriate framing are critical to accurately inform individuals' risk perceptions and their trust in information sources.[5] Perceived risk may be a stronger predictor than actual risk when one is examining whether individuals follow recommended public health guidelines, as studies on the H1N1 outbreak of 2009 have shown.[6,7] The ease with which information can now be disseminated has posed particular challenges for public health messaging in the midst of the COVID-19 pandemic: misinformation and myths have

circulated widely via the internet; have undermined efforts at prevention, mitigation, and, most recently, vaccination; and have resulted in fear and confusion.[8] Individuals have a vast array of information to sort through and evaluate to develop an accurate perception of risk and to effectively manage it.[9] Knowledge of and attitudes toward an infectious disease can significantly affect individual decision-making and, consequently, the course of an outbreak.[10]

There is little published literature on the knowledge, attitudes, and practices of patients with cancer regarding COVID-19. Existing studies have focused on patients with specific cancers or on the broader outlook of patients toward the pandemic. In a study of 156 patients with lung cancer conducted in Italy in April and May 2020, 21% of the patients were more worried about COVID-19 than their own cancer.[11] This phenomenon was also found to be more pronounced among patients with long-term diagnoses. Other studies have found that a majority of participants feared the pandemic more than they did cancer itself.[12] Zuliani et al[13] found acceptance among patients for most prevention measures; the exception was telephone appointments, which substantial numbers of patients regarded as inadequate, although a survey of patients at the same cancer center being studied in this article found high levels of satisfaction with virtual care.[14] Ciążyńska et al,[15] in a study of 260 patients with cancer in Poland in March 2020, found significantly lower self-reported quality of life among patients during the pandemic in comparison with the general population.

This study aims to report the impact of COVID-19 on cancer patients' psychological well-being and access to cancer health care services. It further aims to investigate their knowledge, attitudes, and practices regarding COVID-19 and the sources of information consumed. To our knowledge, this is the first single study assessing the knowledge, attitudes, and practices of patients with cancer with respect to COVID-19 with a robust sample size allowing for the recognition of potential knowledge gaps, informing efforts at reducing anxiety, and improving communication with patients with cancer.

MATERIALS AND METHODS

Data Sources

The study used a cross-sectional design, with a survey administered to patient participants recruited from a large academic cancer center in Toronto, Canada. Patients were eligible if they were at least 18 years old, were able to read and write in English, and were currently receiving cancer care. Ethics approval was obtained (REB# 20-5589).

A link was sent out with email addresses obtained from the hospital's Virtual Care Management System, which included patients who had at least 1 virtual care appointment between March and July 2020; patients were invited to complete the anonymous survey on the LimeSurvey online platform (GNU General Public License). The survey was first sent out on July 22, 2020. A reminder invitation was sent out on July 29, and a final notice for participants to complete the survey was issued on August 5, 2020. The survey was largely adapted from a World Health Organization document entitled *Monitoring Knowledge, Risk Perceptions, Preventive Behaviours and Trust to Inform Pandemic Outbreak Response*, which recommends a target of 1000 participants to ensure a representative sample.[16]

The survey was designed to 1) report the impact of COVID-19 on cancer patients' perceived psychological well-being and experience in accessing cancer health care services and 2) investigate patient's COVID-19 information use, related knowledge, attitudes, and practices. It consisted of 91 items divided into the following sections: demographics, health literacy, psychological impact, treatment impact, trust and use of information sources, knowledge, attitudes, and practices. This breakdown was also made with the World Health Organization's *Survey Tool and Guidance* document for studies seeking behavioral information on COVID-19.[17] Health literacy was assessed with a validated, single-item screening tool asking the following question: "Are you comfortable filling out medical forms on your own?" This tool is concordant with measures of functional health literacy that are focused on measuring the ability of individuals to read, write, and use numbers in the context of health. This single-item measure was selected because these skills are fundamental to using health information and because of its brevity.[18] Low health literacy is associated with worse health outcomes and is higher among the elderly, those with less education, and those from racialized communities.[19,20] The survey questions were designed to conform with principles of plain-language communication; input was sought from experts in oncology education, and the authors reviewed the best practices found in the literature.[21,22]

A study by Zhong et al[23] was used to formulate a question regarding patient attitudes. Psychological well-being questions were adapted from a 2003 study of the SARS outbreak, a survey that in turn was validated with the Stanford Acute Stress Reaction Questionnaire.[24,25] Those 7 items were adapted to reflect COVID-19, and 1 additional question was included to understand perceived financial strain related to the pandemic.

The survey comprised 8 sections. Section 1 (demographics) asked participants about their age, gender, income, education, race, living arrangements, cancer type, and other personal characteristics. Section 2 (treatment impact and concerns) focused on impacts on cancer treatment modalities and timelines during the pandemic. For example, participants were asked if their treatment was delayed and, if so, for how long. They were also asked to rate their concern over whether the pandemic might adversely affect their prognosis (referred to as *cancer worry*) and whether they feared infection at the hospital on 5-point Likert scales. Section 3 (COVID-19 information sources and quality) asked participants to select from a list the sources that they consulted for information about COVID-19 and to rate the frequency with which they sought information from the sources. They were also asked to evaluate the quality of the different information sources in the context of COVID-19. Section 4 (psychological impact) asked participants to indicate the psychological impact of COVID-19 by rating their agreement on statements concerning fears and anxieties with respect to the pandemic. Questions asked respondents if they felt isolated, had difficulty with sleeping or focusing on tasks, had feelings of anxiety and irritability, and feared that they themselves or their loved ones might contract the virus. Section 5 (knowledge) asked participants true or false questions to gauge their knowledge of the symptoms of COVID-19, risk factors, transmission, and prevention according to what was known about the virus at the time of the survey's deployment. Section 6 (practices) asked participants to answer yes or no to whether they adhered to best practices aimed at preventing the spread of COVID-19, including hand washing, the wearing of masks, and social distancing measures. Using a 5-point scale, section 7 (attitudes) included questions about participants' attitudes to the pandemic to determine whether they thought that it could be controlled, whether they thought that the cancer center was doing an adequate job in response, and whether they were confident that they could avoid infection personally. Section 8 (discrimination) asked the participants 6 questions related to racism and the pandemic, including whether one should avoid people from Italy and China (countries that were first hit by the virus), whether they had witnessed or were the target of a racist incident, and the nature of that incident. Section 9 (most needed information) comprised 2 open-ended questions asking participants to indicate their most pressing information needs and asking for any additional comments (see the supporting information for the survey).

Statistical Analysis

Descriptive statistics were computed. To investigate factors associated with cancer worry, knowledge, attitudes, and practices, multivariable models were fit with candidate predictor variables informed by both a priori hypotheses of which variables would be significant and univariate regressions. To reduce the likelihood of type I errors, Bonferroni corrections were applied to univariate regressions for each outcome to identify significant predictors. For continuous outcomes (cancer worry, COVID-19 knowledge, COVID-19–related attitudes, and engagement in preventive practices), linear regressions were modeled; model assumptions were checked with plots of standardized residuals and normal Q-Q plots.

For the regression analyses, some variable categories were collapsed and were coded as follows: education, low (some high school and grade school), medium (some college and college), or high (postgraduate); race/ethnicity, White or non-White; income, <$40,000, $40,000 to $60,000, $60,000 to $100,000, or >$100,000; and cancer type, solid tumors or blood cancers. Continuous measures of cancer worry, psychological impact, and knowledge were computed by summation of the relevant survey questions (see the supporting information for scoring). Information sources and information quality items were collapsed from 5-point Likert scales to 3-point ones for analysis.

The most used information sources were identified by the percentages of participants who answered "often" or "always" in reporting their usage. To determine factors associated with the use of information sources, multivariable ordinal regression models were fit. The assumption of proportional odds was assessed visually by comparisons of logit spacing across categories in the manner described by Harrell.[26] The Holm-adjusted *P* value was calculated to control for multiple testing and held the type I error rate for each analysis at 5%.

Data derived from the 2 open-ended questions at the end of the survey were organized and analyzed with the qualitative data software program NVivo (QSR International, Melbourne, Australia). The responses were categorized thematically with inductive coding and were summarized with representative quotations.

RESULTS

The invitation to complete the survey was sent via email to 5800 patients with cancer, and 1631 complete responses were obtained (a 28% response rate).

TABLE 1. Participant Demographics (n = 1631)

Variable	No. (%)
Gender	
Male	747 (46.8)
Female	847 (53.1)
Other	2 (0.1)
Missing	35
Age, y	
Mean (SD)	62.10 (13.44)
Median	64
Range	18-95
Missing	65
Country of birth	
Canada	949 (59.5)
Other	645 (40.5)
Missing	37
Language spoken at home	
English	1352 (85.4)
Other	232 (14.6)
Missing	47
Understand health information in English	
Yes	1558 (98.0)
No	32 (2.0)
Missing	41
Comfort filling out medical forms (health literacy)	
Yes	1486 (93.3)
No	107 (6.7)
Missing	38
Race/ethnicity	
White/Caucasian/European	1191 (74.4)
East Asian	90 (5.6)
Black/African	55 (3.4)
South Asian	66 (4.1)
South East Asian	54 (3.4)
Arab/West Asian	24 (1.5)
Latin American/Latino	19 (1.2)
Indigenous	15 (0.9)
Other	52 (3.3)
I prefer not to say	34 (2.1)
Missing	31
Highest level of education completed	
Grade school	25 (1.6)
Some high school	55 (3.4)
High school	169 (10.6)
Some college/university	265 (16.6)
College/university	706 (44.1)
Postgraduate school	369 (23.1)
Other	11 (0.7)
Missing	31
Annual household income	
Marital Status	
Single	196 (12.3)
Married/Common law	1111 (69.6)
Separated/Divorced	181 (11.4)
Widowed	203 (6.5)
Other	5 (0.3)
Missing	35
First Language	
English	1204 (75.3)
Other	395 (24.7)
Missing	32
<$40,000	227 (14.3)
$40,000-$59,999	182 (11.5)
$60,000-$79,999	173 (10.9)
$80,000-$99,999	162 (10.2)
≥$100,000	508 (32.1)
I prefer not to say	333 (21.0)
Missing	46

TABLE 1. *Continued*

Variable	No. (%)
Main work-related activity	
Working (part-time or full-time)	596 (37.3)
Student	19 (1.2)
Homemaker	101 (6.3)
Getting disability payment	191 (12.0)
Unemployed	79 (4.9)
Retired	553 (34.6)
Other	57 (3.6)
Missing	35
Living arrangements	
Alone	299 (18.3)
With roommates	35 (2.1)
With parents	68 (4.2)
With partner	1076 (66.0)
With children	373 (22.9)
Cancer type	
Blood	335 (21)
Breast	268 (17)
Eye	11 (0.7)
Gastrointestinal	170 (10.7)
Genitourinary	259 (16.3)
Gynecological	169 (10.6)
Head and neck	82 (5.1)
Lung	102 (6.4)
Sarcoma	29 (1.8)
Skin/melanoma	90 (5.6)
Awaiting diagnosis	24 (1.5)
I don't know	49 (3.1)
Other	5 (0.3)
Missing	38
Treatment stage	
Newly diagnosed and no treatment yet	80 (5.2)
Newly diagnosed and getting treatment	272 (17.5)
Recently finished treatment (<3 mo after treatment)	135 (8.7)
Short-term follow-up (<1 y after treatment)	155 (10.0)
Long-term follow-up (>1 y after treatment)	399 (25.7)
Remission and monitoring	215 (13.9)
Recurrent cancer and started treatment	227 (14.6)
Recently finished treatment for recurrent cancer	67 (4.3)
Missing	81

Descriptive Statistics

The participants were less commonly male than female (47% vs 53%), and the majority were married or in common-law relationships (70%). Sixty percent were born in Canada, and three-quarters spoke English as their first language. The majority indicated their race/ethnicity as White/Caucasian/European (74%), with all other racial/ethnic groups constituting a quarter of the participants (23%). Participants were as young as 18 years and as old as 95 years, with the median age being 64 years. Ninety-eight percent reported being able to understand health information in English, and 93% indicated that they were comfortable filling out medical forms on their own; this corresponded to a largely health-literate sample (Table 1).

The majority of the participants (60%) attended college or university. Most were either working full-time or part-time (37%) or retired (35%); substantial minorities were unemployed, were on disability, or were homemakers (for

TABLE 2. Treatment Impact of Coronavirus Disease 2019

Variable	No. "Yes"
Change in treatment	
Delayed by <2 wk	43
Delayed by <2 wk but <3 mo	166
Delayed by >3 mo	40
Delayed by >3 mo but <6 mo	54
Delayed by >6 mo	14
No change: appointments carried out as planned	503
In-person visits changed to phone or video	1047
Delayed and I don't know when it will be rescheduled	22
What part of treatment was delayed?	
In-person appointments with oncologist	527
Access to imaging services to see cancer growth/return	107
Access to supportive services	78
Access to surgical procedures	172
Does not apply; care was not delayed	877

a combined total of 23%). Household income was diverse, with all ranges similarly represented. The largest income range constituted the 32% of participants who reported an income greater than $100,000. The most common cancers among the participants were blood (21%), breast (17%), and genitourinary cancers (16%). Approximately one-quarter of the participants were following up 1 year after the completion of their treatment, and there were also substantial numbers of newly diagnosed patients and patients who were just beginning treatment (Table 1).

As for treatment impact and concerns, treatment plans for most participants remained unchanged; for 1047 patients, their in-person appointments were switched to virtual ones because of the pandemic (Table 2). In terms of the impact on cancer treatment (cancer worry), 37.2% of participants disagreed or disagreed strongly that the pandemic would make it harder to get cancer care in the future and 39.9% participants disagreed or disagreed strongly that they would experience complications with their treatment due to the pandemic (Table 3). On the questions about psychological impact of COVID-19, most participants worried about themselves (62%) or loved ones (78%) contracting the virus. A majority of the participants (71%) felt socially isolated, although a majority (55%) also indicated that they did not have difficulty with sleeping (Table 4).

Patients consulted a variety of sources for information concerning the pandemic. Television news was consumed often/always by 63% of the participants, and this was followed by online news (56%) and public health sources (54%). There was a substantial degree of neutrality in assessing the quality of sources, which, in the comments section, participants attributed to the degree of variation within each medium. Participants were less likely to seek information from work colleagues (often/always = 12%)

or from social media (21%); both were rated as less reliable, with 43% and 20% rating social media and work colleagues as a poor or very poor source, respectively (Table 5).

Participants demonstrated considerable understanding about COVID-19, which combined for a median knowledge score of 13.0 out of a possible 14 (Table 6). With respect to attitudes, 70% of the participants felt that the pandemic could be contained, 85% approved of the cancer center's response to it, and 91% were confident that they could avoid infection themselves (Table 7). Participants also reported a high degree of compliance with recommended preventative measures and scored a mean practice grade of 94.80 out of a possible 100 (Table 8).

Most participants (78%) did not witness any incidents of racial discrimination related to COVID-19. Of those who had, 34% witnessed the incident directly, with 6% (n = 19) being the target themselves. Sixty-three percent of these incidents were categorized as verbal harassment (Table 9).

Multivariable Regression

Cancer worry was found to be lower among older patients and greater among those who did not speak English at home, those with low health literacy, and those who used social media frequently. There were no strong independent predictors of COVID-19 knowledge despite some significant associations (race/ethnicity, use of web news, and practicing preventative measures; Table 10).

Age was positively associated with use of television news (although the effect was small) along with the perceived quality of television as a source. The only strong predictor of the use of print news was a perception that it possessed a high degree of quality information regarding the pandemic. Participants with higher levels of education were more likely to use academic journals, as were those who rated the quality of journals highly. Quality perception predicted the use of official public health sources because those who rated public health press releases highly were most likely to use them, as were those who identified themselves as female. Quality perception itself was predicted by the knowledge score and confidence in the cancer center's COVID-19 response in the case of public health department releases; the perceived quality of social media was lower for those with greater knowledge but was rated as more trustworthy by participants born outside Canada (Table 11).

Those who identified as female and those who used cancer center resources were more likely to engage in preventive behaviors, as were those with higher knowledge and well-being scores. Of these, knowledge seemed to be the strongest independent predictor of preventive behaviors.

TABLE 3. Cancer Worry

I Am Worried/Afraid That …	No. (%)					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Missing
The COVID-19 pandemic and the response to it will make it hard for me to get cancer care in the future.	190 (12.1)	393 (25.1)	467 (29.8)	398 (25.4)	118 (7.5)	65
I will experience complications with my current cancer treatment because of the COVID-19 pandemic.	71 (12.5)	156 (27.4)	191 (33.6)	119 (20.9)	32 (5.6)	1062
My cancer will return and not be detected or managed properly because of the COVID-19 pandemic.	147 (9.0)	318 (33.3)	258 (27.0)	165 (17.3)	68 (7.1)	675
I will get COVID-19 by coming to the cancer center.	125 (14.3)	325 (37.1)	227 (25.9)	171 (19.5)	27 (3.1)	756

Worry score
- Mean (SD): 2.8 (1.0)
- Median (range) : 3.0 (1-5)

Abbreviation: COVID-19, coronavirus disease 2019.

TABLE 4. Psychological Impact of COVID-19

Question	No. (%)						
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Does Not Apply	Missing
It has been difficult to focus on tasks because of concerns about COVID-19.	157 (10.4)	407 (26.9)	285 (18.8)	493 (32.5)	140 (9.2)	33 (2.2)	116
It has been difficult for me to sleep because of concerns about COVID-19.	289 (19.1)	542 (35.7)	329 (21.7)	254 (16.7)	64 (4.2)	39 (2.6)	114
I have had fears about getting COVID-19.	90 (5.9)	216 (14.2)	250 (16.4)	641 (42.1)	309 (20.3)	17 (1.1)	108
I have had fears of family/loved ones getting COVID-19.	52 (3.4)	110 (7.3)	152 (10.0)	778 (51.3)	402 (26.5)	22 (1.5)	115
I have had fears of friends getting COVID-19.	59 (3.9)	146 (9.6)	298 (19.7)	766 (50.4)	229 (15.1)	18 (1.2)	115
I have felt socially isolated from friends and family because of COVID-19.	63 (4.2)	184 (12.1)	162 (10.7)	626 (41.3)	456 (30.1)	24 (1.5)	116
I have felt angry and irritable because of COVID-19.	177 (11.7)	397 (26.2)	379 (25.0)	382 (25.2)	149 (9.8)	33 (2.2)	114
I have felt anxious about financial concerns because of COVID-19.	182 (12.0)	394 (26.1)	298 (19.7)	386 (25.5)	199 (13.2)	53 (3.5)	119

Psychological impact score
- Mean (SD): 66.40 (16.0)
- Median (range): 67.50 (20.0-100.0)

Abbreviation: COVID-19, coronavirus disease 2019.

Those who identified as female and those with higher psychological well-being mean scores were less likely to believe that COVID-19 could be controlled. The odds of experiencing racism were 1.7 times higher for non-White participants than White participants (Tables 10 and 11).

Open-Ended Comments
The survey included space for participants to document their most pressing information needs. Participants wanted to know more about the vaccines (n = 71), preventative behaviors (n = 42), information on the spread of the virus, where new cases were occurring (n = 27), the relationship between COVID-19 and cancer, the extent to which patients were at greater risk, and the ramifications of immunosuppression (n = 24). In addition to these general concerns, participants also asked specific questions (n = 14) about COVID-19 in relation to chemotherapy, the breast cancer drug tamoxifen, and

TABLE 5. Usage and Quality of Information Sources for Coronavirus Disease 2019

Source of Information	No. (%)			
	Never/Rarely Very Poor/Poor	Sometimes Neutral	Often/Always Good/Excellent	Missing
Television stations				
Usage	302 (19.5)	275 (17.7)	975 (62.8)	79
Quality/trustworthiness	144 (9.4)	410 (26.9)	971 (63.7)	106
Usage	830 (55.6)	241 (16.1)	423 (28.3)	137
Quality/trustworthiness	131 (9.0)	630 (43.5)	687 (47.4)	183
Websites or online news pages				
Usage	290 (18.9)	378 (24.6)	867 (56.5)	96
Quality/trustworthiness	129 (8.7)	611 (41.3)	741 (50.0)	150
Public health department and press releases				
Usage	275 (18.1)	431 (28.3)	815 (53.6)	110
Quality/trustworthiness	48 (3.2)	240 (16.2)	1198 (80.6)	145
Usage	285 (18.7)	660 (43.3)	580 (38.0)	106
Quality/trustworthiness	223 (14.9)	792 (53.0)	478 (32.0)	138
Conversations with work colleagues				
Usage	968 (65.3)	343 (23.1)	172 (11.6)	148
Quality/trustworthiness	280 (20.0)	891 (63.7)	228 (16.3)	232
Journal articles				
Usage	838 (57.1)	456 (31.1)	173 (11.8)	144
Quality/trustworthiness	101 (7.1)	692 (48.7)	629 (44.2)	209
Social media				
Usage	883 (58.7)	308 (20.5)	312 (20.8)	128
Quality/trustworthiness	623 (43.4)	611 (42.5)	203 (14.1)	194
Search engines				
Usage	587 (38.9)	523 (34.6)	400 (26.5)	121
Quality/trustworthiness	200 (13.8)	758 (52.3)	490 (33.8)	183
Radio stations				
Usage	722 (48.0)	456 (30.3)	325 (21.6)	128
Quality/trustworthiness	171 (11.9)	664 (46.0)	608 (42.1)	188
Cancer center resources				
Usage	953 (63.2)	394 (26.1)	161 (10.7)	123
Quality/trustworthiness	76 (5.3)	585 (41.0)	767 (53.7)	203

stem cell transplants. Regarding the vaccines, which were then still in development, participants were concerned about whether the vaccines could be safely administered to patients with cancer and whether patients with cancer would be prioritized as well as their efficacy and the duration of immunity. Participants also responded with further questions (n = 15) about the virus itself, including the possibility of fomite transmission, how long SARS-CoV-2 could survive in the air, and what one could expect after recovering from the disease (eg, whether it would confer immunity and the potential long-term complications). Participants also called for improved communication regarding appointment statuses (n = 12) and access to support services, including help in dealing with isolation (n = 9).

DISCUSSION

The results of this study provide a useful depiction of the state of cancer patients' treatment and psychological well-being as well as their knowledge, attitudes, and practices between the first and second waves of the COVID-19 pandemic. Our study population captured a large number of patients with various types of cancers and treatment stages from which to make inferences. Unlike other studies that recorded greater concern among those undergoing active treatment,[27] we found no association between worry over the virus and stage of treatment.

Health literacy, critical in assessing patient attitudes and practices with respect to COVID-19, was high: the majority of our sample reported being comfortable with filling out medical forms and were generally well educated. Consequently, our well-educated sample may limit our ability to gauge the impact of the pandemic and COVID-19 knowledge, attitudes, and practices on patients with cancer with less educational attainment because previous research has connected the impact of COVID-19 on patients with cancer to their education and job security.[28]

The majority of the participants in our sample were White/Caucasian/European, and although race/ethnicity did not emerge as a significant predictor of any outcomes in this study, consideration must be given to the unequal effects of the pandemic on many racial and ethnic groups,

TABLE 6. Knowledge About COVID-19

Question	No. (%)			
	Correct	Incorrect	I Don't Know	Missing
Symptoms of COVID-19 include fever, fatigue, dry cough, and muscle pain.	1436 (95.0)	31 (2.1)	45 (3.0)	119
Unlike the common cold, stuffy nose, runny nose, and sneezing are less common in people who have COVID-19.	557 (38.3)	561 (37.2)	370 (24.5)	123
Right now, there is no cure for COVID-19, but catching symptoms early and getting treatment can help patients recover from the virus.	1199 (79.4)	172 (11.4)	139 (9.2)	121
Not all people with COVID-19 will develop to severe cases. Seniors and people with chronic illnesses are more likely to be severe cases.	1461 (96.6)	25 (1.7)	26 (1.7)	119
Eating or touching wild animals can cause you to become sick with the COVID-19 virus.	978 (64.7)	139 (9.2)	394 (26.1)	120
People with COVID-19 cannot give the virus to others when they do not have a fever.	1382 (91.8)	44 (2.9)	80 (5.3)	125
The COVID-19 virus spreads via respiratory droplets through coughing, sneezing, or intimate contact.	1476 (90.5)	12 (0.8)	20 (1.3)	123
Wearing a medical mask can help prevent the COVID-19 virus from spreading.	1463 (89.7)	16 (1.1)	28 (1.9)	124
Children and young adults do not have to take measures to prevent the spread of the COVID-19 virus.	1444 (95.8)	37 (2.5)	27 (1.8)	123
To prevent the spread of COVID-19, people should limit (stop) going to crowded places and limit taking public transportation.	1400 (92.8)	65 (4.3)	43 (2.9)	123
Isolation and treatment of people with COVID-19 are ways to slow down the spread of the virus.	1476 (97.8)	13 (0.9)	20 (1.3)	122
People who have contact with someone who has the COVID-19 virus should be isolated in a safe place for at least 14 d.	1488 (98.5)	6 (0.4)	17 (1.1)	120
The incubation period of COVID-19 can be up to 14 d.	1404 (93.0)	18 (1.2)	87 (5.8)	122
People with cancer have to be more careful than other people to protect themselves against COVID-19.	1394 (92.3)	31 (2.1)	86 (5.7)	120

Knowledge score
- Mean (SD): 12.30 (1.60)
- Median (range): 13.0 (0-14.0)

Abbreviation: COVID-19, coronavirus disease 2019.

TABLE 7. Attitudes About COVID-19

Question	No. (%)					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Missing
Do you think the COVID-19 pandemic can be successfully controlled?	177 (11.8)	864 (57.7)	321 (21.4)	122 (8.1)	13 (0.9)	134
Do you think that Princess Margaret Cancer Centre has done a good job of responding to the COVID-19 pandemic?	558 (37.4)	706 (47.3)	211 (914.1)	13 (0.9)	4 (0.3)	139
As a person affected by cancer, do you feel confident that you know what to do to protect yourself from COVID-19?	498 (33.3)	871 (58.2)	99 (6.6)	27 (1.8)	2 (0.1)	134

Do you think that you should avoid people from countries where the first COVID-19 outbreaks occurred, such as China or Italy?
- Yes: 283 (17.4)
- No: 975 (59.8)
- I don't know: 175 (10.7)
- I prefer not to say: 10 (3.7)

Abbreviation: COVID-19, coronavirus disease 2019.

which have put people of color at greater risk of getting sick and dying of COVID-19.[29,30] With social and racial inequity and injustice in mind, it is important to note that the term *racial and ethnic minority groups* includes people of color with a wide variety of backgrounds and experiences. Racism and some social determinants of

TABLE 8. Coronavirus Disease 2019 Practices

Action	No. (%)			
	Yes	No	Does Not Apply	Missing
Hand washing for 20 s	1491 (99.1)	11 (0.7)	3 (0.2)	126
Did not touch your eyes, nose, and mouth with unwashed hands	1381 (91.8)	114 (7.6)	9 (0.6)	127
Used disinfectants to clean your hands	1477 (98.1)	25 (1.7)	3 (0.2)	126
Stayed home when you were sick or had a cold	980 (65.1)	2 (0.1)	523 (34.8)	126
Did not go near someone who was sick or had a cold	1203 (79.9)	53 (3.5)	250 (16.6)	125
Wore personal protective equipment when leaving home	1464 (97.5)	29 (1.9)	8 (0.5)	130
Only made essential trips outside of the home	1386 (92.1)	85 (5.6)	34 (2.3)	126
Did not go to crowded places	1425 (94.7)	62 (4.1)	17 (1.1)	127
Practiced social distancing as much as possible	1489 (99.1)	5 (0.3)	8 (0.5)	129
Self-quarantined	691 (45.9)	320 (21.3)	493 (32.8)	127
Practice score				
• Mean (SD): 94.80 (8.9)				
• Median (range): 100 (0-100)				

TABLE 9. COVID-19 and Discrimination

Question	No. (%)
Have you seen, heard, or experienced any incidents of discrimination related to COVID-19?	
Yes	330 (22.1)
No	1163 (77.9)
Missing	138
What was your role?	
You were the target	19 (5.8)
You witnessed it	110 (33.6)
You supported someone who experienced it	55 (16.8)
Other	143 (43.7)
Where did this occur?	
In a grocery store	78 (23.9)
Online	60 (18.4)
On the street	54 (16,6)
On public transportation	23 (7.1)
In a business	20 (6.1)
In a workplace	9 (2.8)
In a residence	8 (2.5)
In a hospital or medical setting	12 (3.7)
School setting	2 (0.6)
Other	60 (18.4)
What type of discrimination occurred?	
Verbal harassment	204 (63.0)
Shunned	28 (8.6)
Physical assault	14 (4.3)
Barred from public services	1 (0.3)
Online harassment	23 (7.1)
Coughed or spat at	16 (4.9)
Workplace discrimination	1 (0.3)
Barred from business	1 (0.3)
Police-related	2 (0.6)
Other	34 (10.5)
Was the situation handled or resolved?	
Yes	97 (29.7)
No	61 (18.7)
I don't know	169 (51.7)

Abbreviation: COVID-19, coronavirus disease 2019.

health prevent people within these groups from having fair opportunities for economic, physical, and emotional health.[31] Indigenous people in particular were underrepresented in our study. Future research should focus on how race/ethnicity influences access to information and health services related to the pandemic and beyond.

As expected, the majority of patients with cancer have had their appointments moved to virtual modalities to reduce the number of people in the cancer center in alignment with social distancing practices. Another study at the same cancer center found that delays in treatments, including surgery, have likely contributed to a fair degree of concern among patients about the effect of the pandemic on their prognoses. The negative association between age and worry, a phenomenon reported in similar studies of patients with cancer during the pandemic,[32,33] may indicate the degree to which older patients are prepared emotionally for death and disease as well as their ability to limit contacts. The increased worry among patients with limited English language proficiency points to the need for hospitals and public health officials more broadly to better communicate the risks related to COVID-19 across language barriers. To prevent the use of potentially unreliable sources among social networks and online media, hospitals and public health officials must emphasize the dissemination of clear and accurate information to these populations by incorporating the principles of plain language. This holds particular urgency in Canada, where the populations most likely to have low English proficiency are also at greatest risk for infection with the coronavirus.[34]

The majority of the participants demonstrated that they were knowledgeable about the pandemic and optimistic about efforts to bring it under control. The open-ended feedback, in particular, demonstrates the desire for clear and actionable information on the part of patients in areas such as testing, vaccination, and the effect of the return to school and work on transmission. Participants expressed recognition of the vulnerability of patients with cancer and were

TABLE 10. Multivariate Analysis

	No.	Estimate (95% CI)	P	Holm-Adjusted P
Model 1. Cancer worry				
Age	1437	−8.7e−03 (−0.01 to −4.9e−03)		<.001
Language at home	1437			.025
English	1234	Reference		
Other	203	0.19 (0.04 to 0.34)		
Comfort with forms	1437			<.001
Yes	1342	Reference		
No	95	0.40 (0.20 to 0.61)		
Use of social media	1437			.036
Never/rarely	851	Reference		
Sometimes	292	0.04 (−0.09 to 0.17)	.53	
Often/always	294	0.17 (0.04 to 0.31)	.01	
Model 2. Knowledge mean score				
Health information in English	1353			.56
Yes	1329	Reference		
No	24	−0.18 (−0.77 to 0.42)		
Ethnicity	1353			.016
White	1084	Reference		
Non-White	269	−0.28 (−0.47 to −0.09)		
Education	1353			.11
Low	211	Reference		
Medium	832	0.25 (0.02 to 0.47)	.03	
High	310	0.33 (0.07 to 0.59)	.013	
Use of web news	1353			<.001
Never/rarely	251	Reference		
Sometimes	335	0.21 (−0.03 to 0.45)	.084	
Often/always	767	0.47 (0.25 to 0.68)	<.001	
Use of public health press	1353			.25
Never/rarely	245	Reference		
Sometimes	389	0.18 (−0.05 to 0.41)	.12	
Often/always	719	0.22 (7.1e−03 to 0.44)	.043	
Practice mean score	1353	0.02 (8e−03 to 0.03)		.0011
Model 3. Practicing preventative behaviors				
Gender	1362			<.001
Male	640	Reference		
Female	722	1.85 (0.93 to 2.77)		
Cancer type	1362			.63
Blood	301	Reference		
Solid tumor	1061	−0.27 (−1.36 to 0.82)		
Use of cancer center materials	1362			.0033
Never/rarely	860	Reference		
Sometimes	358	1.58 (0.53 to 2.63)	.0031	
Often always	144	1.99 (0.48 to 3.50)	.0097	
Knowledge sum score	1362	0.64 (0.34 to 0.93)		<.001
Psychological impact mean score	1362	0.05 (0.02 to 0.08)		.0025

eager to learn how best to protect themselves. This indicates that patients feel that they have considerable unmet information needs. Some of this may be attributable to the difficulty of early messaging during the pandemic as health officials themselves began to grasp the nature of the disease, and mixed messaging was commonplace, particularly with respect to the risk of contracting the virus. It remains essential that patients receive clear, unambiguous messaging to dispel myths and misinformation and be provided the information that is needed to act. Hospital patient education programs and communication departments should be engaged in this work, and efforts should be made to ensure that health care providers feel equipped to respond to patient questions.

The analysis indicates the importance of language proficiency, education, and information sources in shaping patient attitudes toward the pandemic. The plethora of contradictory information available on the pandemic makes it challenging for patients to evaluate sources and subsequently assess risk accurately.[35] Participants cited difficulty with assessing the quality of entire media (eg, television stations and journal articles) because the quality within each type of media could vary considerably. Use of social media, however, indicated greater worry among participants, and this may point to the availability of misinformation online. The low quality of online information on COVID-19 may be creating confusion among those who frequent social media to learn about the disease.[36,37]

As others have argued, the disruption caused by the COVID-19 pandemic may not register among patients with cancer to the extent that it does generally because

TABLE 11. Multivariate Analysis

	No.	Odds Ratio (95% CI)	P	Holm-Adjusted P
Model 1. Use of television				
Age	1485	1.04 (1.03-1.05)		<.001
Quality of TV	1485			<.001
Very poor/poor	141	Reference		
Neutral	390	1.93 (1.32-2.82)	<.001	
Good/excellent	954	11.77 (8.10-17.11)	<.001	
Model 2. Use of websites or online news pages				
Age	1379	0.98 (0.97-0.99)		<.001
Comfort with forms (health literacy)	1379			<.001
Yes	1295	Reference		
No	84	0.32 (0.20-0.51)		
Education	1379			<.001
Low	210	Reference		
Medium	844	1.85 (1.34-2.55)	<.001	
High	325	2.82 (1.94-4.11)	<.001	
Knowledge sum score	1379	1.18 (1.09-1.27)		<.001
Psychology mean score	1379	1.01 (1.01-1.02)		<.001
Quality of web news	1379			<.001
Very poor/poor	116	Reference		
Neutral	567	2.09 (1.43-3.06)	<.001	
Good/excellent	696	8.40 (5.67-12.44)	<.001	
Model 3. Use of conversations with friends and family				
Gender	1436			.0013
Male	678	Reference		
Female	758	1.40 (1.14-1.71)		
Psychology mean score	1436	1.01 (1.01-1.02)		<.001
Quality of friends/family	1436			<.001
Very poor/poor	211	Reference		
Neutral	765	2.93 (2.16-3.96)	<.001	
Good/excellent	460	10.96 (7.80-15.41)	<.001	
Model 4. Use of print news				
Education	1395			.0011
Low	203	Reference		
Medium	869	0.85 (0.62-1.17)	.33	
High	323	1.41 (0.98-2.02)	.067	
Quality of print news	1395			<.001
Very poor/poor	122	Reference		
Neutral	613	1.50 (0.92-2.43)	.1	
Good/excellent	660	9.90 (6.13-15.98)	<.001	
Model 5. Use of journals				
Education	1380			.0017
Low	209	Reference		
Medium	852	1.55 (1.08-2.20)	.016	
High	319	2.05 (1.38-3.04)	<.001	
Quality of journals	1380			<.001
Very poor/poor	96	Reference		
Neutral	670	1.37 (0.81-2.34)	.24	
Good/excellent	614	7.30 (4.29-12.39)	<.001	
Model 6. Use of Public health department information				
Gender	1449			<.001
Male	684	Reference		
Female	765	1.44 (1.18-1.77)		
Quality of Public health department information	1449			<.001
Very poor/poor	43	Reference		
Neutral	233	0.99 (0.52-1.88)	.98	
Good/excellent	1173	5.91 (3.21-10.90)	<.001	
Model 7. Conversations with work colleagues				
Age	1285	0.99 (0.98-1.00)		.034
Work status	1285			<.001
Working (part-time or full-time)	522	Reference		
Student	16	0.51 (0.18-1.48)	.22	
Homemaker	73	0.15 (0.08-0.30)	<.001	
Getting disability payment	160	0.20 (0.13-0.31)	<.001	
Unemployed	64	0.48 (0.27-0.84)	.01	
Retired	450	0.22 (0.15-0.31)	<.001	

TABLE 11. *Continued*

	No.	Odds Ratio (95% CI)	P	Holm-Adjusted P
Quality of conversations with colleagues	1285			<.001
Very poor/poor	251	Reference		
Neutral	822	3.56 (2.38-5.33)	<.001	
Good/excellent	212	23.03 (14.41-36.81)	<.001	
Model 8. Use of social media				
Age	1222	0.96 (0.95-0.98)		<.001
Gender	1222			.03
Male	571	Reference		
Female	651	1.43 (1.10-1.86)		
Language at home	1222			.46
English	1057	Reference		
Other	165	1.17 (0.80-1.72)		
Ethnicity	1222			.042
White	990	Reference		
Non-White	232	1.52 (1.09-2.13)		
Work status	1222			.46
Working (part-time or full-time)	477	Reference		
Student	14	1.89 (0.58-6.19)	.29	
Homemaker	75	0.69 (0.40-1.21)	.2	
Getting disability payment	153	0.76 (0.51-1.12)	.16	
Unemployed	63	1.15 (0.65-2.04)	.64	
Retired	440	0.71 (0.50-1.03)	.069	
Psychology mean score	1222	1.01 (1.01-1.02)		.0046
Quality of social media	1222			<.001
Very poor/poor	534	Reference		
Neutral	521	3.91 (2.94-5.20)	<.001	
Good/excellent	167	42.38 (27.46-65.42)	<.001	
Model 9. Use of search engines				
Age	1365	0.98 (0.97-0.99)		<.001
Health information in English	1365			.25
Yes	1342	Reference		
No	23	0.50 (0.15-1.63)		
Comfort with forms	1365			<.001
Yes	1283	Reference		
No	82	0.33 (0.19-0.59)		
Education	1365			.011
Low	202	Reference		
Medium	841	1.39 (1.00-1.92)	.05	
High	322	1.81 (1.25-2.61)	.0016	
Quality of search engine	1365			<.001
Very poor/poor	186	Reference		
Neutral	717	3.40 (2.38-4.87)	<.001	
Good/excellent	462	20.54 (13.87-30.42)	<.001	
Model 10. Use of radio				
Quality of radio	1415			<.001
Very poor/poor	163	Reference		
Neutral	649	3.74 (2.31-6.07)	<.001	
Good/excellent	603	33.50 (20.41-54.99)	<.001	
Model 11. Use of cancer center resources				
Cancer journey	1326			.0014
New or remission	253	Reference		
In treatment	425	1.32 (0.94-1.85)	.11	
Follow-up	648	0.79 (0.57-1.10)	.16	
Practice mean score	1326	1.03 (1.01-1.05)		<.001
Cancer center pandemic response	1326			.046
Agree/strongly agree	1126	Reference		
Neutral	183	0.61 (0.41-0.90)	.014	
Disagree/strongly disagree	17	1.15 (0.39-3.44)	.8	
Quality of cancer center materials	1326			<.001
Very poor/poor	71	Reference		
Neutral	539	1.22 (0.57-2.57)	.61	
Good/excellent	716	8.35 (4.02-17.33)	<.001	
Model 12. Quality and trustworthiness of TV				
Age	1493	1.02 (1.01-1.03)	<.001	
Model 13. Quality and trustworthiness of print news				
Age	1411	1.01 (1.01-1.02)		<.001

TABLE 11. *Continued*

	No.	Odds Ratio (95% CI)	P	Holm-Adjusted P
Education	1411			<.001
Low	211	Reference		
Medium	875	1.47 (1.10-1.96)	.01	
High	325	2.56 (1.82-3.60)	<.001	
Model 14. Quality and trustworthiness of Public health department information				
Comfort with forms	1418			.23
Yes	1331	Reference		
No	87	0.73 (0.44-1.22)		
Education	1418			.012
Low	217	Reference		
Medium	874	1.78 (1.23-2.57)	.0022	
High	327	1.81 (1.17-2.82)	.0081	
Knowledge sum score	1418	1.26 (1.17-1.36)		<.001
Cancer center pandemic response	1418			.0036
Agree/strongly agree	1199	Reference		
Neutral	204	0.60 (0.42-0.86)	.0051	
Disagree/strongly disagree	15	0.25 (0.08-0.73)	.012	
Model 15. Quality and trustworthiness of conversations with friends and family				
Country of birth	1478		<.001	
Canada	893	Reference		
Other	585	1.57 (1.24-1.98)		
First language	1478		.55	
English	1124	Reference		
Other	354	1.09 (0.83-1.42)		
Model 16. Quality and trustworthiness of conversations with work colleagues				
Work status	1344			<.001
Working (part-time or full-time)	544	Reference		
Student	16	0.37 (0.14-0.98)	.046	
Homemaker	79	0.88 (0.55-1.40)	.58	
Getting disability payment	166	0.70 (0.49-1.00)	.051	
Unemployed	71	0.80 (0.48-1.34)	.4	
Retired	468	0.53 (0.41-0.69)	<.001	
Model 17. Quality and trustworthiness of journal articles				
Education	1096			<.001
Low	147	Reference		
Medium	686	1.67 (1.16-2.42)	.0059	
High	263	3.54 (2.30-5.44)	<.001	
Income	1096			<.001
<$40,000	190	Reference		
$40,000-$59,999	155	1.43 (0.93-2.18)	.1	
$60,000-$99,999	288	1.36 (0.94-1.97)	.1	
≥$100,000	463	2.20 (1.54-3.12)	<.001	
Knowledge sum score	1096	1.14 (1.05-1.23)		.0016
Model 18. Quality and trustworthiness of social media				
Country of birth	1088			.0014
Canada	685	Reference		
Other	403	1.63 (1.25-2.11)		
Language spoken at home	1088			.022
English	937	Reference		
Other	151	1.62 (1.12-2.34)		
Education	1088			.005
Low	144	Reference		
Medium	687	0.77 (0.55-1.09)	.14	
High	257	0.50 (0.33-0.75)	<.001	
Income	1088			.022
<$40,000	190	Reference		
$40,000-$59,999	160	0.68 (0.46-1.02)	.063	
$60,000-$99,999	289	0.73 (0.51-1.05)	.088	
>$100,000	449	0.55 (0.39-0.78)	<.001	
Knowledge sum score	1088	0.92 (0.86-0.99)		.031
Model 19. Quality and trustworthiness of cancer center resources				
Cancer center pandemic response	1381			<.001
Agree/strongly agree	1172	Reference		

TABLE 11. *Continued*

	No.	Odds Ratio (95% CI)	P	Holm-Adjusted P
Neutral	192	0.41 (0.30-0.55)	<.001	
Disagree/strongly disagree	17	0.12 (0.04-0.33)	<.001	
Model 20. Belief that COVID-19 can be controlled				
Gender	898			.0037
Male	439	Reference		
Female	459	0.61 (0.46-0.82)		
Worry mean score	898	1.01 (0.69-1.47)		.97
Psychology mean score	898	0.98 (0.97-0.99)		<.001
Access to future care	898			.67
Agree/strongly agree	337	Reference		
Neutral	274	0.73 (0.45-1.16)	.18	
Disagree/strongly disagree	287	0.62 (0.34-1.16)	.13	
Fear cancer not managed properly	898			.67
Agree/strongly agree	438	Reference		
Neutral	239	0.74 (0.48-1.15)	.18	
Disagree/strongly disagree	221	1.00 (0.54-1.87)	1	
Model 21. Experience of racism				
Ethnicity	1411			<.001
White	1131	Reference		
Non-White	280	0.58 (0.43-0.77)		

Abbreviations: COVID-19, coronavirus disease 2019; PH, public health.

of the degree to which their existing diagnosis has already upended their lives.[38] Practices aimed at preventing the spread of the virus, such as handwashing, are already habitual among patients with cancer because of their time spent in hospital settings and with potentially compromised immune systems.

It should be noted that during this period, the Canadian government had instituted a comprehensive benefit package that kept most nonessential workers at home. The period in which the survey was completed also remains thus far the point at which cases and deaths were at their lowest since the outbreak hit North America in late February 2020, and cases began to rise sharply the following month. This may be reflected in the feedback related to fears and attitudes, with participants having a false sense that the worst had passed. Since the survey's completion, the country has experienced second and third waves, and it is now entering a fourth wave, with cases surpassing and deaths approximating the highs witnessed in the spring of 2020 during the third wave.[39] At the time of the survey, schools had resumed some in-person learning, and some nonessential businesses had returned briefly before being shuttered again.

Knowledge of how to treat the virus has steadily improved since. Research indicates that those hospitalized with COVID-19 have experienced better outcomes in the months since the end of the first wave than they did before it.[40] The results also reflect a period in which there were no vaccines available and only the first clinical trials had commenced. The vaccination drive and the prospect of some return to normalcy in the near future would likely produce different responses if the survey were administered today. Previous studies in virus hotspots during the early days of the crisis found high degrees of depression, fear, and anxiety among patients with cancer.[41] A study using publicly available data from online cancer support networks and social media found a sharp decrease in positive sentiments among patients with cancer beginning in February when the disease began to take hold of populations globally.[42] Future studies should analyze data from more recent periods of the pandemic when cases better reflect the gravity of the crisis and the public's understanding of the disease has become more refined. A study conducted today would also be better positioned to understand the effect of the outbreak on attitudes toward racialized populations in light of the violence toward people of Asian descent.

The results of this study can be used to better comprehend the needs and concerns of patients with cancer for the duration of this pandemic and can likely be generalized to concerns during potential future outbreaks of infectious diseases.

This study, however, suffers from the limitation that the participant population was better educated and less diverse than the local population. As discussed, the majority of the participants in this study had high levels of education. This could be a result of a nonresponse sample bias where the method of data collection used unintentionally biased individuals with lower education attainment to decline participation in the study. Although we made efforts to mitigate this possibility by writing the study questions

in plain language and using short measures where possible, participants were still required to complete a long survey. It is also possible that volunteer surveys such as this will recruit those most well adapted to managing cancer and COVID-19 in comparison with the general patient population, and future studies may need to use purposive sampling to better understand the effect of the pandemic on cancer patients of different social strata.

In conclusion, this study sought to report the impact of COVID-19 on patients with cancer in terms of their psychological well-being and the impact on cancer care services. It further aimed to investigate the knowledge, attitudes, and practices of patients with cancer regarding COVID-19 and the sources of information consumed. Most participants saw their treatments made virtual, with a minority experiencing delays. Patients exhibited strong knowledge of COVID-19 and adherence to preventative practices, with knowledge being the greatest predictor of engagement in these practices. Participants who had limited English proficiency, had lower health literacy, or frequently used social media as a source for information about COVID-19 experienced more worry than their counterparts. This study indicates that there are gaps in communication directed toward patients with cancer and limited English proficiency, who are more likely to have lower levels of health literacy. Concerted efforts by hospitals and public health officials are needed to produce clear and actionable information for patients that is available in multiple languages.

CONFLICT OF INTEREST DISCLOSURES
The authors made no disclosures.

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Mohamed A. Ugas: Data curation, formal analysis, investigation, validation, methodology, writing–original draft, and writing–review and editing. **Diana Samoil:** Data curation, formal analysis, investigation, validation, and writing–review and editing. **Lisa Avery:** Data curation, formal analysis, investigation, validation, and writing–review and editing. **Alejandro Berlin:** Conceptualization, data curation, formal analysis, investigation, and writing–review and editing. **Meredith E. Giuliani:** Conceptualization, formal analysis, investigation, supervision, and writing–review and editing. **Tina J. Papadakos:** Conceptualization, formal analysis, investigation, supervision, and writing–review and editing. **Naa (Linda) Kwarley Quartey:** Conceptualization, data curation, formal analysis, investigation, methodology, project administration, and writing–review and editing. **Janet K. Papadakos:** Conceptualization, data curation, formal analysis, investigation, methodology, project administration, supervision, validation, writing–original draft, and writing–review and editing.

REFERENCES
1. Coronavirus disease (COVID-19) pandemic: numbers at a glance. World Health Organization. Published March 2021. Accessed September 8, 2021. https://www.who.int/emergencies/diseases/novel-coronavirus-2019
2. Yu J, Ouyang W, Chua MLK, Xie C. SARS-CoV-2 transmission in patients with cancer at a tertiary care hospital in Wuhan, China. *JAMA Oncol*. 2020;6:1108-1110.
3. Liang W, Guan W, Chen R, et al. Cancer patients in SARS-CoV-2 infection: a nationwide analysis in China. *Lancet Oncol*. 2020;21:335-337.
4. Desai A, Gupta R, Advani S, et al. Mortality in hospitalized patients with cancer and coronavirus disease 2019: a systematic review and meta-analysis of cohort studies. *Cancer*. 2021;127:1459-1468.
5. Reynolds B, Seeger MW. Crisis and emergency risk communication as an integrative model. *J Health Commun*. 2005;10:43-55.
6. Reintjes R, Das E, Klemm C, Richardus JH, Kebler V, Ahmad A. "Pandemic public health paradox": time series analysis of the 2009/10 influenza A/H1N1 epidemiology, media attention, risk perception and public reactions in 5 European countries. *PLoS One*. 2016;11:e0151258.
7. Rubin GJ, Amlôt R, Page L, Wessely S. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross sectional telephone survey. *BMJ*. 2009;339:b2651.
8. Roy D, Tripathy S, Kar SK, Sharma N, Verma SK, Kaushal V. Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian J Psychiatr*. 2020;51:102083.
9. Zarocostas J. How to fight an infodemic. *Lancet*. 2020;395:676.
10. Janz NK, Becker MH. The Health Belief Model: a decade later. *Health Educ Q*. 1984;11:1-47.
11. Catania C, Spitaleri G, Del Signore E, et al. Fears and perception of the impact of COVID-19 on patients with lung cancer: a mono-institutional survey. *Front Oncol*. 2020;10:584612.
12. Haddad FG, Kourie HR, Gebara N, et al. Cancer patients in the era of coronavirus: what to fear most? *J Patient Saf*. 2021;17:e35-e38.
13. Zuliani S, Zampiva I, Tregnago D, et al. Organisational challenges, volumes of oncological activity and patients' perception during the severe acute respiratory syndrome coronavirus 2 epidemic. *Eur J Cancer*. 2020;135:159-169.
14. Berlin A, Lovas M, Truong T, et al. Implementation and outcomes of virtual care across a tertiary cancer center during COVID-19. *JAMA Oncol*. 2021;7:597-602.
15. Ciążyńska M, Pabianek M, Szczepaniak K, et al. Quality of life of cancer patients during coronavirus disease (COVID-19) pandemic. *Psychooncology*. 2020;29:1377-1379.
16. Monitoring Knowledge, Risk Perceptions, Preventative Behaviours to Inform Pandemic Outbreak Response. World Health Organization; 2020. WHO/EURO:2020-696-40431-54222.
17. World Health Organization. Survey Tool and Guidance: Rapid, Simple, Flexible Behavioural Insights on COVID-19. World Health Organization; 2020.
18. Chew LD, Bradley KA, Boyko EJ. Brief questions to identify patients with inadequate health literacy. *Fam Med*. 2004;36:588-594.
19. Institute of Medicine (US) Committee on Health Literacy, Nielsen-Bohlman L, Panzer AM, Kindig DA, eds. Health Literacy: A Prescription to End Confusion. National Academies Press (US); 2004.
20. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. *Ann Intern Med*. 2011;155:97-107.
21. Flower JF. Survey Research Methods. SAGE Publications; 2013.
22. Artino AR Jr, La Rochelle JS, Dezee KJ, Gehlbach H. Developing questionnaires for educational research: AMEE guide No. 87. *Med Teach*. 2014;36:463-474.
23. Zhong BL, Luo W, Li HM, et al. Knowledge, attitudes, and practices towards COVID-19 among Chinese residents during the rapid rise period of the COVID-19 outbreak: a quick online cross-sectional survey. *Int J Biol Sci*. 2020;16:1745-1752.
24. Landis MS, Bradley JW. The impact of the 2003 SARS outbreak on medical students at the University of Toronto. *Univ Toronto Med J*. 2005;82:158-164.
25. Cardena E, Koopman C, Classen C, Waelde LC, Spiegel D. Psychometric properties of the Stanford Acute Stress Reaction Questionnaire (SASRQ): a valid and reliable measure of acute stress. *J Trauma Stress*. 2000;13:719-734.

26. Harrell FE Jr. Regression Modeling Strategies: With Applications to Linear Models, Logistic and Ordinal Regression, and Survival Analysis. Springer; 2015.

27. Lou E, Teoh D, Brown K, et al. Perspectives of cancer patients and their health during the COVID-19 pandemic. *PLoS One*. 2020;15:e0241741.

28. Chapman B, Swainston J, Grunfeld EA, Derakshan N. COVID-19 outbreak effects on job security and emotional functioning amongst women living with breast cancer. *Front Psychol*. 2020;11:582014.

29. Stokes EK, Zambrano LD, Anderson KN, et al. Coronavirus disease 2019 case surveillance — United States, January 22–May 30, 2020. *MMWR Morb Mortal Wkly Rep* 2020;69:759-765.

30. Killerby ME, Link-Gelles R, Haight SC, et al. Characteristics associated with hospitalization among patients with COVID-19 — Metropolitan Atlanta, Georgia, March–April 2020. *MMWR Morb Mortal Wkly Rep*. ePub: 17 June 2020.

31. U.S. Department of Health and Human Services. Social Determinants of Health [online]; 2020. Accessed June 2020. https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-healthexternalicon

32. van de Poll-Franse LV, de Rooij BH, Horevoorts NJE, et al. Perceived care and well-being of patients with cancer and matched norm participants in the COVID-19 crisis: results of a survey of participants in the Dutch PROFILES registry. *JAMA Oncol*. 2021;7:279-284.

33. Büssing A, Hübner J, Walter S, Gießler W, Büntzel J. Tumor patients' perceived changes of specific attitudes, perceptions, and behaviors due to the COVID-19 pandemic and its relation to reduced wellbeing. *Front Psychiatry*. 2020;11:574314.

34. van Ingen T, Akingbola S, Brown KA, et al. Neighbourhood-level risk factors of COVID-19 incidence and mortality. *medRxiv*. 2021; Preprint. doi:10.1101/2021.01.27.21250618

35. Papadakos J, Reznikov V, Giannopoulos E, et al. The literacy demand of cancer & COVID-19 consumer health information. *J Consum Health Internet*. 2021;25:50-64.

36. Szmuda T, Syed MT, Singh A, Ali S, Özdemir C, Słoniewski P. YouTube as a source of patient information for coronavirus disease (COVID-19): a content-quality and audience engagement analysis. *Rev Med Virol*. 2020;30:e2132.

37. Jayasinghe R, Ranasinghe S, Jayarajah U, Seneviratne S. Quality of online information for the general public on COVID-19. *Patient Educ Couns*. 2020;103:2594-2597.

38. Millar C, Campbell S, Fisher P, Hutton J, Morgan A, Cherry MG. Cancer and COVID-19: patients' and psychologists' reflections regarding psycho-oncology service changes. *Psychooncology*. 2020;29:1402-1403.

39. Johns Hopkins University. Coronavirus resource center: COVID-19 dashboard. Accessed April 2021. https://coronavirus.jhu.edu/map.html

40. Shim E. Regional variability in COVID-19 case fatality rate in Canada, February-December 2020. *Int J Environ Res Public Health*. 2021;18:1839.

41. Chen G, Wu Q, Jiang H, et al. Fear of disease progression and psychological stress in cancer patients under the outbreak of COVID-19. *Psychooncology*. 2020;29:1395-1398.

42. Moraliyage H, De Silva D, Ranasinghe W, et al. Cancer in lockdown: impact of the COVID-19 pandemic on patients with cancer. *Oncologist*. 2021;26:e342-e344.